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AUDITORY SENSATIONS AND RELATED PHENOMENA

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The trend of acoustic research since the last summary was published (**40**) has been largely in two directions: (1) The further inquiry into detailed conditions under which hearing is effected and (2) the development and discussion of auditory theories. As noted before, the technique of the oscillating circuit with its possibilities of exact control and the determination of precise units of intensity and frequency has been responsible for a more careful scrutiny of the facts in the auditory field. Again, also, we must note that it is hardly feasible to draw the line between contributions which are made by psychologists, otologists, physiologists, and physicists; nor is it possible in a review of this character to take note of every published work that has appeared from each of these sources. Accordingly, unless hampered by inability to reach the original material, the reviewer has charged himself with the responsibility of critically analyzing the more significant researches in each of the chief fields of investigation. It is still the reviewer's hope that at some time in the near future a more adequate clearing-house in the form of an institute for acoustic research will be provided and established. Many investigators do not at present seem to be sufficiently informed of analogous experiments that are being performed in a field contiguous to their own.

Theory of Audition. We noted in our last review the persistent attacks upon the Young-Helmholtz theory. This criticism has continued vigorously and several radically new proposals have been made. Boring (**5**) has taken into account some of the recent hypotheses of neural impulse and conduction, and has made new proposals

to combine what is known as a " frequency-theory " with a form of Watt's theory of overlapping " cortical excitation." On grounds that are logically and physically well taken, Boring assumes that it is no longer possible to establish an auditory *quale* on any basis of local sign, even though rigorously modified; nor can auditory *quanta* be definitely connected with a theory that involves the specific energy of nerves. The reviewer can not agree with Boring, however, in his refusal to use such a concept as " 11,000 auditory sensations," because obviously the term " sensation," like the term " simple reflex " in physiology, or the term " ion " in physics, is in a certain sense an artifact of science. When it becomes necessary to tie up each *quale* in a continuous series of elemental auditory phenomena with definite neural connections, the task is not unlike one in which Pratt (32) and others are engaged when they seek to discover the physical limits of what might phenomenologically be considered a musical interval. Furthermore, the facts of absolute-pitch consciousness have many times revealed the exactness of pitch designations, both as regards frequency, or pitch, and timbre-quality. As the facts appear in one phase of Boring's theory the principle of sympathetic resonance is still to remain as an outstanding contribution of Helmholtz and, while we may have to give up other phases of the Helmholtz theory, it may still be said that the mechanical feature, though somewhat modified in its interpretation, remains intact. In hearing, the theory of excitation is itself different from the corresponding theories in other sense departments, especially where a complex end-organ is involved. It seems, therefore, more plausible to the reviewer to follow the stimulus inward, and first make improvements in the concept of the mechanical excitation of the end-organ such as Banister (3) has proposed. Both Boring and Banister approach their theories of hearing mainly in the light of problems concerning sound-localization. It is of interest to a psychologist to note that whereas Boring claims the time theory to be a general case of the intensity theory, and the phase theory to be in turn a special case of the time theory, so Banister is moved to consider that the main stress should be placed on phase effects. Banister meets the reviewer's chief contention by suggesting that the differential effect occurs through the movement of the cilia of the hair-cells in his statement that " the nervous impulse in the auditory nerve fiber is initiated when the cilia are in a certain phase of their cycle." Of course this does not meet Boring's criticism that there can not be a one to one relation between the auditory qualities and the selective sensory mechanism

because there is no fixed physical relationship. What we need most of all, at the present time, is more detailed discussion of the mechanism of hearing, to which, of course, a discussion of the neurological conditions will indirectly contribute. When all is said and done, a theory must take into account not only the problem of sound localization and the attributes of auditory sensations, but also the phenomena of beats, difference tones, and intertones.

One of the most thoroughgoing summaries of both the facts and theories of audition has been made by Knudsen and Jones (**24**). Not only are the facts of normal hearing adequately reviewed, but those of abnormal hearing met with in the clinic and discussed in the otological literature are likewise brought to bear on available theories. Among the former sets of facts are included discriminations of intensity—in the study of which the authors themselves have made notable contributions,—pitch discriminations coupled with intensity through the ten octaves of pitch range, beats, the localization of sound, the nature of vowels and consonants, subjective difference tones, and the masking effect of one tone upon another. Among the abnormal phenomena are mentioned diplacusis, or the consistent hearing of different tones for the same frequency; otosclerosis, or the abnormal invasion of the internal ear; tonal depressions, or the more modern interpretation of "tonal islands," and the work in animal experimentation. The theories are treated under the two general captions of the harp and the telephone theories. In reviewing modifications of the earlier telephone theories down to the present time, in which Rinne, Voltalini, Rutherford, Waller, Ewald, ter Kuile, Meyer, and Watt each have made individual contributions, Knudsen and Jones find decided advantages in this theory.

> "The mechanism of the stapes and the cochlear tube is adapted for gross displacement of the entire membraneous cochlea; the continuity of the cochlear membranes, from the base to the apex, suggests that the vibrating membrane acts as a diaphragm rather than as individual fibers; the assumption that this continuous membrane vibrates as a whole, makes it easier to account for the very great damping of tones that does occur within the cochlea. In addition, the 'harp' theory confronts the difficulties of the infrequent occurrence of diplacusis and also the extraordinary requirements of the length, tension and mass of the receptors within the cochlea."

On the other hand, recent neurological research involving the "all or none" principle leads the authors to accept the harp theory as being, on the whole, a better form of explanation. Even with full

knowledge concerning the recent discoveries of the "carrier" frequencies in telephonic operation—facts which the training of the authors, as physicists, would easily lead them to appreciate,—they have decided that the selectivity of a resonator system has much to its advantage. They are convinced, of course, that the action of the combined mass must be considerably damped and they are much influenced by Hartridge's work considered in our previous summary, in which he was able to reverse the phase through an ingenious device in connection with a siren, thereby producing a momentary cessation followed by a stimulation of the same tonal sensation which gradually came back to its original intensity. Their own contribution consists in the summary conclusion that "the particular theory that appears most reasonable is the theory of maximal amplitude which postulates that there is a series of resonators within the cochlea very closely coupled so that one can not act without causing its immediate adjacent structures to participate in the vibration."

It may not be out of place here to note briefly that Ogden's (33, p. 46f)* recent treatise on hearing leans somewhat in the same direction, and that Seashore's (43, p. 56) introductory text considers the harp theory more plausible than the telephone theory. From opposite points of view Scripture (44) and Paget (34) have commented briefly on the plausibility of the resonance theory when modified to suit recent contributions in the field of audition. Scripture contends that physical and physiological conditions do not favor a theory that demands the selective resonance of the basilar fibers to tones rapidly changing in pitch. He holds to a cerebral analysis of impulses arising from a basilar membrane that is deformed in three dimensions. In a work that deserves a separate review, Wilkinson and Gray (54) have given the theory further sanction by their comprehensive study of the mechanism of the cochlea. Köhler likewise has gone into the underlying neurology of the ear (25) in an attempt to justify conclusions based on the *Gestalttheorie*.

Quantitative Aspect of Sound. Work continues in the direction of measuring stimuli applied to the ear in terms of small units of physical intensity. We can no longer be satisfied with determinations of *j.n.d.* of pitch without at the same time establishing the relative and absolute intensities at which these pitches are given. Even so well known a phenomenon as the beating complex is conditioned by the relative intensities at which the primary tones are

* A review of the treatise appeared in this BULLETIN, 1925, 22, 480 ff.

sounded. Eberhardt (11), using two primary tones at eight cycles difference, reports that when the primary tones were of unequal intensity all of her observers agreed in hearing one beating tone or intertone. These *O*s agreed also that when the intensity of the two primary tones was made equal or nearly so, two tones, though not the two primary tones, were heard beating. One of these tones was near the pitch of the louder primary, the other one was from two to five cycles less than the louder, *i.e.*, toward the lower tone. In nearly all cases the beating tones were heard simultaneously with the primary tones. It is to be noted that Stumpf was one of the *O*s in these experiments. For the purpose of measuring the respective intensity of tones, Lewin (27) has constructed an amplifying device capable of enlarging the excursion of the sounding membrane 600,000 times. Webster's phonometer, described in our last summary, was capable of magnifying these effects only 2,400 times. Lewin's apparatus consists principally of a mirror attached to a very fine curved hair which rests on a saddle mounted on the membrane. He can also use the principle of light interference, as it is best known in the Michelson interferometer, by taking the sodium line of the spectrum through two glass plates which are adjustable to a critical angle in relation to the excursion of the membrane. Of course the final amplification of sound is measured by reflection of the beam of light from the extremely small mirror. The apparatus was used chiefly in conjunction with interference tubes to produce beating effects under controlled conditions. The interference tubes were employed to eliminate overtones and thus to deliver pure tonal stimuli. The same criticisms that Henning has directed against monorhinic stimulation in connection with olfactory experiments is reëmphasized in some of the work of Young (56), who has studied the dichotic *vs.* monotic sensibility of the human ear to small differences in frequency and intensity with 40 *O*s, 9 women and 31 men. There were three sets of problems: one involving a constant pitch in the neighborhood of 1,600 cycles with varied levels of loudness; another using a tone at a constant level of loudness with variable pitches from 64 to 4,096 cycles; and a third with this tone subject to variations in frequency from 4,000 to 8,000 cycles. In each of these cases the pitch sensibility was measured through the inverse ratio of a barely perceptible change in pitch to the pitch itself, first for each ear separately, then with the two ears functioning together. The apparatus used was a special circuit employing the vacuum tube oscillator whose plate-resistance was kept sufficiently high to pro-

duce approximately pure tones. The results of this experiment show in brief that sensibility in both ears is appreciably better than in either ear alone, and increasingly so as the frequency increases and as the intensity values decrease. A useful chart is shown comparing the results of Knudsen, Luft, Meyer, Stucker, Young, and Vance in connection with pitch discriminations at various frequencies. Some very minute work has been done by Jones and Knudsen (**18, 19**) on the testing of ears for defects both of a conductive and a perceptive type. In these experiments the instrument was capable of testing the ear in octaves from 64 to 8,192 cycles and also at variable pitches involving small increments. On the basis of these studies the authors are led to believe that some form of the resonance theory of hearing is adequate to explain the facts when there is conductive impairment either in the external auditory canal or through fixation in the middle ear. They have also (**20**) studied the facts concerning paracusis. It has been generally supposed that there is an increase of auditory acuity with the presence of noise, a perversion originally noted by Willis. In a series of examinations of 187 cases 46 per cent of the 56 cases of impairment showed symptoms of paracusis. By means of the vacuum-tube technique the precise intensity at each pitch level could be recorded and pure tones as well as speech sounds could be produced. The noise was made by causing the beating effect of two oscillating circuits of 50,000 and 30,000 cycles respectively to rotate in a vertical plane 15 times per second. The speech sounds were produced by the dictation method used by telephone engineers. With normal subjects the sensibility to pure tones was decreased to 80 per cent in the presence of 20 sensation units of noise, while there was a reduction to almost 70 per cent in the presence of 40 sensation units of noise. Paracustics do not seem actually to hear better in the presence of noise, but only to enjoy a relative advantage, on account of the fact that noises to them are not as disturbing as they are to normal subjects. Furthermore, tones of high pitch produce only a slight masking effect on speech tones which are normally in the neighborhood of 60 to 6,000 cycles. This alleged peculiarity appears to have aroused general interest. One writer (1) takes pains to show that the underlying principle of an inherent inertia of the mechanism that is supposedly overcome through the concomitant vibratory effect of noise is not a foreign concept in applied mechanics. In connection with a small oscillating part of the steam turbine and with a syphon writing point in teleg-

raphy, the initial jarring effect is resorted to in order to provide subsequent sensitivity of response.

A further analysis of auditory defects is offered by Jones and Knudsen (**21**) and a suitable classification of types and degrees of deafness is proposed. In these studies the authors used an audio-amplifier similar in performance to the Western Electric type of instrument. Bunch has also done some valuable work on auditory acuity in otosclerosis (**9**) as well as upon a number of other defects. Sixty-three cases were carefully examined, also involving the method of bone conduction. The author has classified his results under differences of age, sex, sensibility at the lower and upper auditory limits, as well as in connection with tinnitus and paracusis. The Wheatstone-Weber effect was also studied. These cases are classiable into middle ear lesions, inner ear lesions, and combinations of both. Bunch has also compared charts (**8**) obtained by the Western Electric audiometer No. 1-A and the Iowa pitch range audiometer. The advantages and disadvantages of both types of instruments are brought out clearly in dealing with a great variety of case material. The Western Electric audiometer does not seem to show the familiarly known tonal islands and gaps, but other writers have maintained that with careful control of intensities the notion of tonal islands and gaps must be given up because all subjects are capable of hearing all frequencies of tone when the intensity is high enough.

A very comprehensive summary of technical procedures for testing auditory capacities has been made by Fletcher (**14**) in terms of the audion circuit. It is now possible to measure the exact units of intensity, of which there are in the neighborhood of 130. From pianissimo to mezzoforte singing approximately 15 steps have been distinguished depending somewhat on the quality of the stimulating sound. The hearing loss is then measured by a logarithmic equation. It is now customary to speak of these steps an "attenuation units." One unit corresponds to an energy ratio of ten, and two units correspond to an energy ratio of 100. One-half of a unit corresponds to an energy ratio of $\sqrt{10}$, or 3.2. In each case the hearing loss can be determined only by multiplying the result by the variable factor K. Ordinary speech has a factor equal to .83, the 3-A audiometer, 1.0, and the watch-tick, 1.5. Fletcher would have the tuning forks which are used for testing ears marked with their respective damping constants as well as their frequencies in order to facilitate the calculation of attenuation units.

A number of studies have been made by Pohlman and Kranz

(36, 37, 38), principally of phenomena involving bone conduction. The Wheatstone-Weber phenomenon, already mentioned, refers to the lateralization of sound to the ear that is occluded. Wheatstone found in 1827 that when the external meatus is filled with water, sounds received through the bony structure of the head will be referred to the side of the head where water has been introduced. In a preliminary study these investigators found that (1) both sounds transmitted through bone or air normally enter the cochlea through the stapedial foot-plate, (2) that acuity for air-transmitted sound is no criterion for bone-conducted sound, and (3) that bone conduction results in an acuity which is dependent on frequency of the tone, and is extremely variable from individual to individual. With 5 *Os* they investigated the influence of complete and partial occlusion on bone acuity. The ears were sealed with a softened and molded dental impression compound. Five octaves of tones were used from 128 to 2,048 cycles. With the ears plugged, a tone of 128 cycles required 14.5 times its normal intensity for transmission through the bone. At 2,048 cycles the intensity mounted to 1,000 times normal. The writers discuss the practical value of such studies. During the war the ears of the soldiers were plugged so that they would not be sensitive to explosions, but could still hear spoken commands. This practice should be reversed, according to their investigation, since plugging the ears effectively excludes spoken words while noises are still conducted through the bones of the head. In a later study 6 *Os* were tested in order to discover what influence the place of origin of bone conduction has on obstructed ears. Sounds were transmitted from the forehead, from the mastoid adjacent to the filled ear, and from the mastoid on the opposite side of the head. With the ears open there is a better transmission of sound from the mastoids than from the forehead, but hearing was more affected by water when conduction was through the neighboring mastoid than when sounds were transmitted from the forehead. Filling the ear with water causes improvement in bone conduction on the filled side. Dental wax still further increases auditory acuity on the affected side.

Halverson (15) has pursued the question of the status of tonal volume. With the aid of the oscillating circuit his *Os* reported a change in volume with a change in pitch. They had little difficulty in distinguishing the attributes of volume and intensity and his data support his conclusion that these attributes behave like independent variables whose curves can be separately plotted. Stewart has further developed his ingenious method of filtering sound waves in order to

provide relatively pure frequency stimuli for acoustic research (47, 48, 49). Three methods of modifying sound are outlined: (1) a system of resonators at the side of the conduit which cancels the objectionable partials when properly adjusted through interference at opposite phase, (2) absorbent material introduced as lining in the conduit which dissipates and transforms a part of the energy, and (3) constrictions and expansions built into the conduit which reduce the partials by mutual interference through reflection and ultimate absorption of energy. Three types of filters are now available: a high-frequency pass filter, a low-frequency pass filter, and a combination of these two which allows sound of only a narrow band of frequencies to pass. Mathematical data are appended to his studies giving the physical characteristics of these sound filters, which were suggested by the widely used electrical filters in oscillating circuits. R. C. Travis (52) utilized auditory and visual thresholds as diagnostic devices for distinguishing psychoneurotic individuals from schizophrenic types during induced periods of revery. The former type showed almost uniformly an individual lowering of these thresholds in order to elicit response in comparison with normal conditions, *i.e.*, a weaker stimulus than normal strength was required. The latter type showed a marked relative raising of these thresholds under similar conditions as compared with normal responses.

Sound Localization. As has already been noted, the data derived from investigations in sound localization provide pivotal points about which several theories of audition center. Banister (4) discourages the use of what he calls the " dynamic method " of approach in which two tones slightly out of tune are studied in their various phase relationships. The qualitative results of this method are dependable, but there is insufficient control of the initial time of incidence of sound. The static method of conduction through separate tubes is in turn vitiated by the uncontrolled resonance of the conduits. The method of causing phase changes through rotating magnetic fields is objectionable because of possible differential resonance in the telephones. Taking all these objections into consideration, there is no conclusive proof for phase effects in sound localization when physically pure tones were available. Banister also raises an issue which the reviewer stated many years ago, namely the influence of suggestion in those experiments in which the experimenters were also observers. In Banister's series the 7 *O*s were not familiar with the literature concerning the facts of sound localization. In all of the experiments some form of the audion tube circuit was used, but the

investigator makes no claim regarding the purity of tone delivered beyond an approximation to the sinusoidal form. Phase control was effected in the usual manner by adjustment of capacity and impedance while the *O*s brought the localization to the median plane by adjusting the relative intensities of the tones. Under these conditions a normal person can appreciate a phase difference at his ears in tones ranging from 133 to 1,705 cycles. Additional data corresponded with the results of v. Hornbostel and Wertheimer in the fusion of two clicks into one when the clicks were presented in rapid succession, in the localization of the click on the side of the head where it first arrives, and in the determination of the angle to the sagittal plane as being proportional to the temporal difference in the arrival of the clicks. In another set of experiments (2) the intensities of the telephones were controlled through suitable shunts. Tones ranging from 210 to 245 cycles were separately conducted to the ears and the *O*s were thus enabled to appreciate phase differences as distinct from intensive differences. Depending on the quality of the tones the intensity ratios required to produce a phase change of $\pi/2$ ranged from 2.5 : 1 to 11.8 : 1. In support of his recently developed theory of audition (3), already referred to, Banister emphasizes the results obtained with clicks. The critical value in the time-difference of arrival is 1,750 $\sigma\sigma$ or the velocity of sound in air factored into the average distance around the head (57 cm.). A related problem has been investigated by Wittmann (55), who undertook to analyze a situation that was described by Weber in 1846. When two watches of dissimilar ticking rhythms are heard from one side of the head, both the coincident and the aperiodic ticks can be heard with one ear, but when the watches are placed one before each ear, the rhythms can not be distinguished. One watch is perceived to be beating faster than the other. This situation was put under experimental conditions and the results show that coincidences can be heard with dichotic as well as with monotic hearing. The author reaches the conclusion that dichotic sound localization depends as much upon the total intensity of the respective frequencies as upon the time difference of similar points in their phase. In the region of 150 to 1,333 cycles, with a phase difference of 2π for all frequencies, two separate tones of different intensity and therefore of different localization could be distinguished. They might even be simultaneously directed to the left or right of the median plane. But under these circumstances there was a secondary tonal phenomenon, probably similar to what is known to us as the " phantom sound ", which wandered about from

left to right. The main point, however, is that this phenomenon must not be confused with the two generating tones which are simultaneously heard but can be attentively distinguished. The effect must be somewhat like the analyzed beating complex which is receiving further study by Eberhardt, as reported above. The author contends that the time theory of v. Hornbostel and Wertheimer should include the influence of total intensity in the dichotic localization of sound. Kester (**22**) throws further light on this problem of movement of sound under dichotic conditions. He investigated the apparent movement of pairs of noises and concludes that the analysis may go one step farther: there may be a perception of movement without the perception of an object that moves! This, in itself, ought to open new problems in the psychology of movement which might lend color to the claims of *Gestalt* psychology.

Musical Capacities, Song and Speech. The impetus given by Seashore to the application of the facts and principles of auditory sensation in the realm of musical talent continues to show considerable dynamic force. Not only in the laboratory of the University of Iowa, where many studies are still in progress, but in other psychological workshops the continual refinements of method and technique, the more detailed searching into the problem of the musical mind, and the improvement of points of approach, are being carried forward. One of the outstanding contributions has been made by Stanton (**46**) who has had several years' experience in applying the tests of musical ability at the Eastman School of Music in Rochester, New York. She has very conservatively estimated the results of 248 talent charts and compared them with the ratings of 35 teachers of music in that institution. In almost a hundred of these cases the estimate of the Director was also included. Further studies were made with 200 students of piano technique and several groups tested in other years. The progress of students was studied, and other factors were sought for through the questionnaire method. Without going into minutiæ the results are well typified by one of the concluding statements. "At the end of three years, 86.7 per cent or 129 of those who tested D and E [which were the lowest grades] were not enrolled in the school, only 13 per cent or 20 of them were continuing their music lessons, but of those who tested A and B only 36 per cent or 54 of them were not enrolled in the School, 63.7 per cent or 95 of them were continuing their music study." While under present conditions no higher correlation can be shown between test performance and continuous ability, because several other uncon-

trolled factors enter here, as they do in all testing programs, nevertheless, the study clearly shows the great advantage derived from objective tests as compared with the variable outcome of teachers' ratings. In general, however, while the variation of subjective judgments is a disadvantage, the test rating compares very favorably in most cases with the opinion given by experts in musical ability.

Brennan (6) has made a comparison between musical capacity and performance. Twelve separate tests were given in order to determine the sensory capacities, the imagery, and the motor adjustments of the *Os*. The performances of the same *Os* were rated by instructors in the School of Music. After making detailed analyses of the rating charts and variations in judgments, she comes to the conclusion that "the student with superior musical capacity records tends to rank higher in performance than the student with only average or low capacity records." Musical training, however, plays a more important rôle in the performance than it does in the capacity tests. In another study (7) she tested three groups of students, or altogether 100 students, with the tonoscope. The tests involved singing a tone just immediately below and above the standard, singing an interval, and singing a keynote. These tests were tentative in character, and the interrelation between the tests was not high enough to warrant any significant statistical conclusion. A more thoroughgoing approach to singing is that of Metfessel (31) who employed a phono-photographic technique involving the phonelescope. On the film were recorded heart beat, breath pressure, general respiratory and vocomotor contraction, the time line, and the voice curve itself. Analyses were then made through microscopic enlargement. It was also possible to record by ear small variations made when the phonographic records were played very slowly. By this means the emotional expression of music and speech in terms of pitch and duration of notes could be satisfactorily investigated. The same method can be used in connection with faulty speech, as Travis and Davis (51) have shown, and with stuttering, as has been described in some extended work done by Travis (50). Travis and Davis found that the tests for pitch, duration, and tonal memory reveal greater variability in groups of individuals with defective speech than in normally speaking groups. Travis discovered that stutterers show less variability in the maintenance of pitch after an emotional shock than under normal conditions, while non-stutterers experience greater variability of pitch after an emotional disturbance than under normal conditions, and that stutterers have a smaller range in vocal pitch

than non-stutterers in making habitual statements, whereas the conditions are reversed in statements of embarrassment. The non-stutterer has a greater range in pitch when speaking under the influence of relaxation than under conditions of mental strain or threatened injury.

The phenomenological attitude reported in our last summary in connection with the work of E. M. Smith and Bartlett on tones of various degrees of intensity and in the researches of Pratt on bitonal complexes has been extended in the direction of the musical intervals by Edmonds and M. E. Smith (12). When the *O*s were requested to give absolute qualitative descriptions without reference to the usual criteria, the octave was named "smooth," the seventh "astringent," "sharp-rough," the sixth "luscious," "juicy-mellow," the fifth "dilute," "hollow," the fourth "rich," "coarse," "harsh," the third "mellow," "sweet to taste," and the second "gritty," "grating." Moran and Pratt (32) have noted the uncertainty of criteria in the judgment of consonance and have called attention to the significant fact that some *O*s can designate musical intervals as readily and as correctly as the average person perceives red as distinct from green. In other words, intervals are directly perceived as such. Using the Fechner method of average error with Stern variators ranging from 345 to 495 and from 520 to 655 cycles, they aimed to discover the influence of deviations from the normal ratio of frequencies for each interval on the judgment of the interval. The variable was taken both above and below the standard, and there was always a variation in the direction of change. Altogether 40 judgments on each of the 11 intervals, exclusive of the octave, furnished the basis of an average limen for all *O*s and all intervals of about 1/5 of an equal semitone, which reduces considerably Meyer's fraction of 1/3 of an equal semitone. Steps considerably outside of this range up to the midway point for the next interval were not assimilated to the nearest interval. The method proved to be useful also in rating the various degrees of fusion in terms of the variability of judgment from the recognized ratio. Heinlein (16) has vigorously criticized the Seashore test of consonance on the score that since the test follows the procedure of paired comparisons the laws of musical progression and of resolution distort the results to the end that the more musically trained the *O* is, the lower will be his score. Several large groups of undifferentiated subjects were used, as well as practised musicians. On repetition the test revealed internal inconsistencies and external variations as a whole. While the instruction printed in the manual which accompanies the records does not emphasize clearly enough

what criterion is to be used in judging the consonances and dissonances, it is patent that the direction to make cognitive judgments instead of affective reactions was not followed. Peterson voices an obvious objection (35) against the implication in the psychological use of the term "sense of consonance" in that we are then dealing with a phenomenon on the plane of an elemental sense. The expression has its origin very likely in musical phraseology. On the other hand, he argues that in the functional sense the perception of fusion is not readily analyzable into the cognitive and affective elements that Seashore demands. After a very well organized historical critique, Peterson shows that any given perception in one generation is the precipitate of unconscious factors that were the cultivated habits of a previous generation. On this assumption he argues negatively against the positions taken by Helmholtz, Lipps, Stumpf, Watt, and Ogden.

In 1907 Myers asserted that the frequency with which various musical intervals are used in folk music decreases proportionately with their size. Before his untimely and deeply regretted death Watt (53) made a very thorough comparison of Schubert's songs with the songs of the Chippewa and Teton Sioux Indians. Taking a random sampling of every tenth song in a collection of 567, and allowing somewhat for the effect of consonance in progressions, he corroborated Myers' principle. When such corrections are made, and minor passages altogether eliminated, the decrease in frequency with size was about 60 per cent on the basis of a major second being 100 per cent. One hundred and eighty-three Chippewa songs had a similar rating for major intervals up to the 6th and 7th. Incidentally the minor 2nd occurs in primitive song only about 12.7 per cent while in Schubert it is used in 76.8 per cent of the cases. With the exception of the minor second Watt established the principle that an interval is used more often for contrary motion the larger it is.

That tests of musical ability should measure intelligent interpretation of musical phrases and cadences as well as the fundamental technique to express what is desired, must be a part of any thoroughgoing program that aims to analyze the capacities of the ideal musical mind. This feature is admirably brought out by Lowery (30) in his proposed cadence and phrase tests, and is already available in another form in the Kwalwasser Victor record for phonograph use. One series of the Lowery test furnishes a set of major and minor triad cadences in two pairs of two chords each. The instructions call for judgments as to whether the cadence is more or less complete

(M or L). The tabulation of results for 50 girls of from twelve to fourteen years showed a normal distribution. In another series 50 pairs of musical sentences were to be judged as being the same or different in each pair (S or D). Thirty were sentences of 5 notes, 10 were of 6 notes, and 10 were 7 notes long. The results here were also normally distributed, but so far no correlations have been obtained to show whether the musically trained earn higher scores than the unmusically trained.

The problem of motor rhythm has been analytically attacked by R. H. Seashore (**42**) in terms of measures of precision of rhythmic action and other tests of allied motor and cognitive factors, such as eye and hand coördination, steadiness, thrust, motility, reaction-time, and memory span for digits and consonants. Simple memory span and liminal discriminations of small intervals were found to be less important than the capacity to reproduce muscular sets for larger patterns. The reliability coefficient for the test was .89, P. E. .02. Ruckmick (**41**) has shown the analogy of the rhythmic consciousness to other forms of perception under the laws of attention with particular reference to the rôle of motor factors. He has also compiled a supplementary list of bibliographical titles (**39**) bringing the combined references up to date with a total of 714 published works on the various phases of rhythm.

The problems centering in the vocal expression of song and speech, together with their bearing on questions concerning vowel tones and language formation, are being pressed forward by many research students. Knudsen (**23**) has been interested in investigations which have a direct influence on the transmission and reception of speech over the telephone. Studying the interfering effect of tones and noises on speech reception, the interference of intensive effects in tones and noises is approximately in the ratio of geometric progression of interference to an arithmetic increase in intensity. The effect is almost independent of pitch, but the tones of lower pitch create an increasingly greater interference. A noise produces about twice the interference effect of a tone for the same degree of intensity. The study covered all tones from 128 to 4,096 cycles and with "a typical noise." The intensities ranged from bare audibility to the painful limit. From the reviewer's study of noises it appears that it would have been well to carry the investigation on with a great variety of noises, especially in view of the comparative conclusions drawn by the author, and in view of the greater frequency of noisy interferences in general practice. Attention is called to an obvious applica-

tion of these results to the acoustic construction of auditoriums where speech energy should exceed disturbing noises by about 1,000 to 10,000 times, and all tones up to 4,096 cycles should be about equally absorbed. Erickson (13) has made a preliminary survey of all the significant factors that enter into effective vocal expression. The study takes the form of a critical inventory of both the physiological structures and functions and the psychological factors such as the elements of pitch, volume, time, and intensity, as well the more complex perceptions of rhythm, consonance, time, and musical interval. With more specific reference to the underlying physical conditions of vocal and instrumental effects, Simon (45) has compared results made with the " time-line " method of reading phonelescopic records with the " wave-length " method. There is slightly less distortion of results with the latter procedure. After thus examining his technique he made photographic analyses of the tones produced by the cornet, open cello strings, trombone, bassoon, trained voices, fingered cello string, untrained voices, and clarinet. He offers the tentative conclusion that no tones of constant pitch ever appear in vocal or instrumental expression, but that there is a decreasing approximation to a uniform vibrato in the tones produced by the sources mentioned and in the order named. Kwalwasser (26) has made a more minute analysis of the vibrato and its independent variables of pitch, duration, and intensity. The periodicity of any one or more of these varies from 4 to 9 per second. Some cases of " parallel vibrato " were discovered in which both pitch and intensity fluctuated together. After examining 93 trained and 27 untrained singers he believes that nasal placement of tones offers the least fluctuation in the extent of the vibrato while throat placement causes the widest variation.

Liddell (28, 29) is continuing his noteworthy contributions to the scientific analysis of language. He has brought out the fact that vowel quality is the result of an aperiodic sound wave of from 10 to 25 cycles. When a given vowel is intoned there appears a partial or maximal energy with a pitch constant at one or two characteristic frequencies. When uttered in conversational language these vowel qualities can be noted through phonodeiknic analyses of phonographic records by the presence of components of major energy whose mean maximal value is constant and characteristic. The spectral bands of 11 sounds of from 325 to 2,100 cycles are appended. He has also published mathematical equations used in the derivation of some of his results. Crandall and Sacia (10) have also made a careful study of the physical components of vocal sounds by means of a different

technique, and Jaensch and Rothe (17) have undertaken an elaborate defense of their position that vowels lie theoretically midway between tones and noises. Searching through the genetic development of primitive music and speech they locate certain "disturbing factors" which caused the differentiation of tone, vowel, and noise. They contend that vowels are not simply analyzable into elementary tones.

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VISION: (VALUE, CHROMA, AND HUE)

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The last general summary on Vision published by the PSYCHOLOGICAL BULLETIN was that of Troland in 1920. In this paper Troland reviewed the literature for the preceding year (1919). The present review includes articles published between the years 1922 and 1925, inclusive. For papers on the subject of this review published in 1920 and 1921 the reader is referred to Troland's summary in the *Amer. J. Physiol. Optics* (39) and to his monograph *The Present Status of Visual Science* (37).

The articles reviewed in this paper all deal more or less directly with the determinations for the normal eye of the relationships existing between the three attributes of color (value, chroma, and hue) and their corresponding physical stimuli. Since no standard terminology has been followed by writers in the field of color science, it may be well, at this point, to define several of the terms to be employed in this review. The following definitions are taken with slight modifications from a recent report of the Colorimetry Committee of the Optical Society (38). (a) *Color* is the general name for all sensations arising from the activity of the retina of the eye and its attached nervous mechanisms, this activity being, in nearly every instance in the normal individual, a specific response to radiant energy of certain wave-lengths and intensities. (b) *Value* is that attribute of any color in respect of which it may be classed as equivalent to some member of a series of grays ranging between black and white. Synonymous terms used by other writers are brilliance, and (subjective) brightness or luminosity. (c) *Hue* is that attribute of certain colors in respect of which they differ characteristically from the gray of the same value so as to permit them to be classed as reddish, yellowish, greenish, or bluish. (d) *Chroma* is that attribute of all colors possessing a hue which determines their degree of difference from a gray of the same value. It is synonymous with saturation. (e) Colors can be classified as *chromatic* or *neutral* according as they do or do not possess a hue.

I. Value

Of the papers on the general subject of value or brightness sensitivity, two deal with the initial value or achromatic threshold. Monroe (**28**) has determined at seven points in the spectrum the minimum amount of light which can be perceived by the eye. Observations were made by twenty-one observers at the following wave-lengths: 655μ, 616μ, 580μ, 553μ, 522μ, 489μ, and 463μ. The amounts of light required for the initial value-threshold are specified in terms of energy. The data were obtained under dark adaptation with a stimulus field subtending 2° 22′. For nine of the observers the threshold is smallest in the green-yellow (557μ); for the remaining twelve it is smallest in the green (522μ). The latter group have higher average thresholds than the former except at 522μ. Determinations were also made at the same wave-lengths for the chromatic thresholds, *i.e.*, for the minimum amounts of light perceived as chromatic.

Müller (**29**) has investigated the relative magnitudes of the monocular and binocular thresholds for white light with the dark adapted eye. The test objects used subtended visual angles of 14.4° and 27.5°. With monocular vision it was found very difficult to maintain the proper direction of sight. This introduced large variations among the data obtained. The author, therefore, compares the *smallest* rather than the mean threshold values. He concludes that there is no evidence for the assumption that the binocular threshold in dark adaptation is lower than the monocular.

In several articles the relation between intensity of light and the corresponding brightness sensation, or value, is considered. Adams and Cobb (**2**) derive an equation for this relationship from the results of previous investigations by Cobb. In 1916 Cobb published data on the variations in the difference threshold of brightness with independent changes in the brightness of the test field and of the surroundings. From certain assumptions as to the nature of the nerve processes of the retina, Adams and Cobb derive theoretical formulae which are in agreement with the experimental results previously obtained by Cobb. The formula proposed by Adams and Cobb to represent the relation between value (subjective brightness) and physical brightness for a constant adaptation of the eye is $S=B/(B+k)$, where S is the sensation of value, B is the brightness, and k is the brightness of the surrounding field to which the observer is adapted. In a later article Adams (**1**) compares the Fechner, the

Munsell, and other formulae with that derived by Adams and Cobb. The curves corresponding to the various equations are plotted for comparison on a single graph. All the other curves are found to lie between those for the limiting cases of Adams and Cobb's formula, corresponding respectively to constant adaptation to zero and to infinite brightness.

The common assumption that the sensation of gray is an intermediate between black and white is criticized in a brief note by Dimmick (**5**). The series obtained by the mixture of varying proportions of black and white is usually considered to be analogous to that obtained by mixing red and yellow, for example. Dimmick, however, claims, on introspective evidence, that the black-white series is similar to that obtained by mixing complementary hues.

The relation between intensity of stimulation and the electrical response of the retina of a frog's eye has been studied by Chaffee, Bovie, and Hampson (**3**). The methods used advance beyond those of previous investigators in three important particulars: (a) Instead of making the electrical connection with the retina by placing the electrodes in contact with the cornea, a direct connection is made with a small area on the surface of the retina. (b) Very sensitive amplifying apparatus is used in the measurement of the electrical responses. (c) The potential between the optic nerve and a point on the retina is measured without drawing any current or energy from the retina. Consequently, the results are independent of the resistance of the tissues and of other resistances in the circuit. Neutral lights of various intensities are used as stimuli. In order to study the relation between sensation and intensity of stimulus the authors assume that the maximum height of the electrical response-curve gives a measure of the intensity of sensation. For low intensities the magnitude of the electrical response was found to be proportional to the square root of the stimulus. The Weber-Fechner law was found to hold approximately at medium intensities but not at higher intensities. The change from the exponential to the logarithmic relation occurs at 6.3×10^{-4} meter candles.

In the following year Chaffee and Hampson (**4**) published the results of similar investigations with monochromatic lights. Relative energy measurements of the lights used were made by means of a Coblentz vacuum thermopile and a Weston galvanometer. The maximum heights of the response curves, taken as measures of the sensation, are plotted as a function of energy for each wave-length. The results are similar to those obtained with neutral light. Thus,

in the lowest region of intensity, the response was proportional to the square root of the stimulus energy, indicating a linear relation between the *logarithm* of the response and the logarithm of the intensity. For a higher range of intensities a linear relation was found between the response and the logarithm of the intensity; there is, however, a region of still higher intensities for which no law has been deduced. The regions in which the above mentioned laws are valid cover approximately the same ranges of *response* for the various wave-lengths investigated, but cover very different ranges of *intensity*. Consequently, when the visibility curve is determined at a constant level of response, the law involved is the same for the various wave-lengths. When determined at a constant level of energy, however, this is not the case; at some wave-lengths the eye responds according to the logarithmic law, and at others according to the exponential law. A visibility curve determined for the frog's eye shows a maximum sensitivity at 516μ, its general shape being similar to that of the human visibility curve.

A paper by Hartline (**16**) is of interest in connection with the work of Chaffee *et al.* Hartline describes methods by which the electrical response of the retina can be measured without excising the eye, and therefore without disturbing the blood supply to the retina. In the first method decerebrate animals were used. Decerebration served to immobilize the animal, hence no drugs were needed. The electrical responses were obtained by placing non-polarizable electrodes on the cornea and on the cut end of the optic nerve. Experiments were also made in which one electrode was placed on the cornea and the other on a moist surface of the body. These gave results similar to those obtained when the electrode was placed in contact with the optic nerve. The latter method is obviously of great advantage because it permits the use of a human subject. The electrical responses obtained can thus be correlated with the subjective sensations of the observer. In this method, as in the first, the blood supply to the retina is unimpaired, so that no deterioration takes place. The same eye can therefore be studied over a long period of time and under different experimental conditions.

Duschek-Frankfurt (**7**) has investigated the relations of value (or subjective brightness) sensitivity to the hue, value, and chroma of the stimulus. A series of Hering papers of various hues and chromas were examined. The procedure used to determine the value sensitivity for each stimulus was as follows: The pigment surface was illuminated by light from a 600 watt lamp. A second

smaller lamp was used to cast the shadow of a rod on this surface. The distance of the small lamp from the surface was regulated until the shadow became imperceptible. The results indicate that value sensitivity is a complex function of the hue, value, and chroma of the stimulus.

A much investigated aspect of the problem of brightness-sensitivity is the determination of the "visibility function." Gibson and Tyndall (10) have made a new statistical study of the average visibility curve for fifty-two observers. The determinations were made by a modification of the equality of brightness method of photometry known as the step-by-step method, in which photometric comparisons are made in fields differing only slightly in hue. A circular photometric field subtending a visual angle of 3° was used. The state of adaptation of the eyes of the observers is not mentioned. Gibson and Tyndall define visibility at a given wave-length as the ratio of the lumen value to the watt value at that wave-length. The procedure in determining the visibility function is first to obtain by the step-by-step method the luminosity curve of the spectrum for each observer. From these data and the known energy distribution in the spectrum each observer's visibility curve can then be calculated. The luminosity of the spectrum was maximum at 580μ, where it was equivalent to 53 millilamberts viewed through an artificial pupil of 0.25 sq. mm. area. The luminosities at 450μ and 690μ were approximately 0.1 of that at 580μ. The Purkinje effect, the authors believe, may have been present below 450μ.

A number of the observers in Gibson and Tyndall's investigation had made similar determinations in previous studies dealing with the visibility function. Eighteen had acted as observers in the investigation of Coblentz and Emerson, four in that of Hyde, Forsythe, and Cady, and two of these four also in that of Ives. Consequently, a number of very interesting comparisons are made possible between these investigations in which different methods of photometry, sizes of field, and levels of intensity were used. The comparisons between the results of individuals common to two investigations show, on the average, the same sort of agreement or disagreement as do the average curves for all the observers of each investigation. The difference between the visibility data of Gibson and Tyndall and those of Coblentz and Emerson is attributed to the fact that flicker photometry was used in one case and equality of brightness photometry in the other. The difference between Gibson and Tyndall's results and those of Hyde, Forsythe, and Cady is attributed to the different

sizes of photometric field (3° in the former investigation and approximately 10° in the latter). The average data of Ives and of Nutting show extremely wide variations from each other, although determined under similar conditions as to size of field, brightness, and method of photometry. If the two sets of data are averaged, however, they agree very closely with the average visibility data of Gibson and Tyndall. The authors conclude from this that, if the flicker determinations are made by a sufficient number of observers and with the field size and brightness recommended by Ives, and if, furthermore, the determinations by the equality of brightness method do not depart too widely from these conditions, then there is no certain difference between the average results obtained by the two methods of photometry. They conclude, therefore, that field size and brightness are more important in their effect upon the visibility curve than the method of photometry used. They propose a revision of the visibility data adopted by the Illuminating Engineering Society, which gives a better agreement with the results of the various investigations.

Laurens (27) has made a study of the visibility function under various experimental conditions. The determinations of this investigation may be summarized as follows: (1) The relative luminosity curve of an equal energy spectrum was obtained for a high and for a low energy level. (2) Determinations of the visibility curve at a constant brightness level were made at 25, 10, 2.5, 1.0, and 0.2 meter candles. (The effective brightnesses, however, were decreased by the use of an artificial pupil.) (3) Visibility curves were determined with eccentric fixations of 5°, 10°, 20°, and 30° from the center of the photometric field. A two degree stimulus field was used throughout. The eye was dark adapted for the determinations at low intensity, and for those made with eccentric fixations. The arrangement of apparatus was such that the photometric measurements could be made either by the equality of brightness or by the flicker method of photometry. Differences in the results obtained by the two methods were apparently considered of slight importance, since at some intensities the flicker method was used by all the observers, at others the equality of brightness method was used, and at one intensity the former method was used by two of the observers and the latter by four other observers. The equality of brightness method was used in the data obtained with an eccentric fixation. The Purkinje shift in the visibility curve is not found to occur until the intensity level designated as 0.2 meter candle is reached. This intensity, reduced by the artificial pupil used, is below the chromatic

threshold. No significant differences are found in the curves for intensity levels between 25 and 1 m.c. The visibility curve for an eccentric fixation of 5° shows a slight shift towards the blue. It is very similar to the central curve for high intensity when the latter has been corrected for the selective transmission of the macular pigment. The curve at 10° from the center shows a somewhat greater shift toward the blue end of the spectrum. At 20° and 30° from the center the curve is similar to that obtained with central fixation and an intensity of 0.2 meter candle.

The majority of the visibility determinations have been made at a high intensity. In order to supplement these, Hecht and Williams (18) have made a study of the average visibility curve of forty-eight observers determined at a low intensity level and with dark adaptation. The constant comparison light to which the various spectrum lights were equated in brightness consisted of a layer of radium paint the brightness of which was approximately 2.7 times that required for the threshold in dark adaptation. At this level the spectrum lights were below the chromatic threshold so that the difficulties of heterochromatic photometry were avoided. The photometric field subtended a visual angle of 22°. The average visibility curve obtained under these conditions has a maximum at 511μ. The curve is found to coincide very closely with the visibility curve for high intensities determined by Hyde, Forsythe, and Cady if the latter is shifted 48μ toward the blue end of the spectrum. The authors suggest that the visibility curve represents the absorption curve of some photochemical substance, possibly the visual purple. This substance they believe to be dissolved in both the rods and the cones. The difference in the position of the curves for rod and cone vision is due to the fact that in the cones this substance is dissolved in a denser solvent. According to Kundt's rule, this would result in a shift of the absorption curve.

Houston and Heddle (21) have shown that there are marked differences in achromatic sensitivity to red light among individuals of normal color vision. Visibility data obtained previously by Coblentz and Emerson with a flicker photometer showed that there was a very great variation in relative visibility to red. At 655μ the highest relative visibility obtained by any observer was more than three times the lowest. The authors find that, if these results are plotted in the form of a frequency polygon with the number of cases as ordinates and the logarithms of relative visibility as abscissae, the variations in red sensitivity show approximately normal distribution.

The data obtained by Coblentz and Emerson were for 125 observers. In Houston and Heddle's investigation 604 observers, including 56 women, were selected at random from the students in an optics course. The light transmitted through a red glass filter was matched in brightness to a standard amount of light from a carbon lamp. A simple grease spot photometer was used. Each observer made two determinations of the equality point. A frequency polygon is given in which the logarithms of the amounts of red light required are plotted as abscissae. The data form a continuous distribution curve which is slightly asymetrical. The maximum visibility is approximately five times the minimum. The authors estimate that perhaps one-fourth of the scatter is due to error of observation.

Mathematical expressions for the relation between visibility and wave-length have been proposed in several papers. Otashiro (**30**) has shown that the visibility curve can be considered as a composite curve of two or more probability curves. With the proper choice of constants a curve can be obtained by the summation of two probability curves, which is in good agreement with the experimental visibility data obtained by Ives. Gibson and Tyndall (**11**) propose an equation to represent the visibility data recommended by them. The equation is of the form proposed by Goldhammer in 1905. Walsh (**40**) suggests slight changes in the constants of this equation which result in a somewhat closer approximation to the recommended data.

II. Chroma

The only paper dealing with the relation of chroma or saturation to purity of stimulus is that of Donath (**6**). In this investigation the observer was required to select a stimulus which appeared to bisect the sensation interval between a neutral and a highly saturated stimulus. Observations were made under the following three conditions: (1) the neutral matched the chromatic color in value; (2) the neutral was black; (3) the neutral was white. In the first case the midpoint corresponds to the arithmetic mean of the stimuli, *i.e.*, to equal proportions of the chromatic and the neutral component. In the other two cases the midpoint agrees with the geometric mean of the stimuli. The stimuli required to give a just perceptible difference in chroma were determined for the same three experimental conditions. In the first case the increment was found to be constant. In the other two cases it increased in accordance with the Weber law.

Eberhardt (**8**) found that the chromatic threshold was a min-

imum when the value of the background matches that of the test field. The determinations were made by means of rotating discs. The observers were presumably light adapted.

Monroe (**28**) determined for a number of observers the chromatic thresholds at seven points in the spectrum. The observers were dark adapted. The amounts of light required for the threshold are given in energy units. The average chromatic sensitivity was greatest in the green-yellow where 0.086×10^{-12} watts were required for the threshold. The chromatic sensitivity was least in the yellow, where more than 12,000 times the above amount of energy per second were required.

Sinden (**34**) has calculated the relative chromas of spectral stimuli from data on the luminosities of complementary wave-lengths. In order to make these calculations he assumes that "the subjective saturations of two complementaries are inversely proportional to their luminosities." The saturation of the spectrum was a minimum, Sinden found, in the region between 570 and 580μ. Below 500μ there was a very rapid increase in saturation with decrease in wave-length.

Haupt (**17**) has investigated the changes in the chromatic response of the eye to spectrum light with variation in the intensity of the light. Determinations were made at seven points in the spectrum of the amounts of energy required to give the chromatic threshold and each succeeding least perceptible difference in chroma. A stimulus field of approximately 2° was used. Data were obtained for both light and dark adaptation. The sensation of chroma was found to increase with increase in intensity up to a certain point; further increase of intensity beyond this point resulted in a decrease in chroma. The point of maximum chroma for each wave-length is specified both in photometric and in energy units. The number of least perceptibly different steps from the initial threshold to the point of maximum chroma is also given. Maximum chroma occurred at a different level of energy for each of the wave-lengths investigated and for each of the conditions of adaptation. Likewise the photometric value and the number of least perceptibly different steps corresponding to the point of maximum chroma differed for each of the seven wave-lengths and the two states of adaptation.

III. Hue

The sensitivity of the eye to differences in wave-length of spectrum light has been investigated by Laurens and Hamilton (25). Observations were made throughout the spectrum of the difference in wave-length required in order to produce the least perceptible difference in hue. Two slightly different forms of apparatus were used. In the first, the field consisted of a vertical strip 12′ by 3°. In the second arrangement of apparatus, a circular field 3° in diameter was substituted. In making observations the field was maintained at a constant brightness, 15 millilamberts in the first apparatus and 4 photons in the second. The observer was adapted to the dim light of the experimental room. Determinations were made with the first apparatus on seven subjects, and with the second apparatus on four. The authors acted as observers in both cases. The difference in wave-length required for the least perceptible difference in hue was found to be smallest in the yellow and the blue-green. Secondary minima were found in the orange and in the violet. The four regions of minimum threshold corresponded to the regions of greatest change in the relative slopes of the three fundamental sensation curves.

The same authors have investigated (26) the effect on the hue discrimination curve of fatiguing the eye with intense homogenous light. The hue discrimination curves of an eye fatigued with red, green, and blue lights respectively are shown to be in agreement with the known data on the hue discrimination of red-, green- and blue-blind subjects. Fatiguing the eye with orange-red, yellow, blue-green, or white light was found to have no selective effect upon hue discrimination. Fatigue was found to reduce the value and the chroma of the stimulus simultaneously.

Smith (36) points out the need of making determinations of hue sensitivity for purples as well as for spectrum hues. He has investigated the sensitivity of the eye to changes in the amount of red or blue in a mixture of these two lights. The red and blue lights were obtained from Wratten filters. With a fixed amount of red in the field, blue was added until a just perceptible reddish purple was seen. The succeeding steps were determined in the same way by further increasing the amount of blue. The series of least perceptible differences was in general agreement with that obtained when blue light *unmixed* with red was increased by least perceptible steps. In both cases the least perceptible differences increased in magnitude in

agreement with the Weber law. It is not clear to the reviewer whether the object of this investigation was to determine sensitivity to change of hue or to change of intensity. It seems probable that the judgments were made by the observers in terms of the value difference rather than the hue difference.

Göthlin (12) presents data on "the situation and extent of the purely yellow zone in the spectrum." Observations were made by 24 normal observers, 12 of either sex. The eyes of the observers were adapted to an illumination of one meter candle. The color quality of the illumination was matched with that of a sky "free from clouds except an even and uniform covering of cirro-stratus." The sky under these conditions appeared neutral in color quality. The stimuli were narrow bands (less than 0.5μ in all cases) taken from various parts of the spectrum in the region of the yellow. The intensity of spectrum light used was approximately three times that required for the chromatic threshold in the yellow region. No radiation greater than 596μ or less than 574μ was judged as pure yellow by any of the observers; 580μ was judged as pure yellow more frequently than any other. The extent of the pure yellow zone varied with the different observers between 1 and 12μ.

Haupt (17), in an investigation referred to in an earlier part of this review, mentions incidental observations on the changes of hue which accompany changes of intensity of spectrum lights. These changes vary with the state of adaptation of the eye, and also with the relative values or brightnesses of the test field and the surrounding field. With a light surrounding field both red and green tend to become yellowish with increase of intensity. At very low intensities yellow appears green and blue appears purple.

Haas (15) finds that a spectral yellow of 590μ, matched to a mixture of a yellow-red (610μ) and a green (558μ), remains matched when the intensity of both is varied from 90 meter candles to the threshold. A reduction of the time of exposure to as low as 0.01 sec. likewise has no effect on the identical appearance of the two fields.

Sinden (34) presents data on complementary wave-lengths. The neutral standard used in making the determination was an artificial source of light modified by filters so as to be approximately equivalent in hue and in spectral distribution to average noon sunlight. Its intensity was between 75 and 100 photons. The stimulus field subtended a visual angle of 1.5°. One observer determined the complementary wave-lengths at twelve points in the spectrum, the other

seven at four points only. Five of the observers also determined the relative luminosities of the components using the equality of brightness method of photometry.

Schulz (**35**) derives a mathematical relationship between the wave-lengths of complementary colors on the assumption that the organs which respond to the primary colors act as resonators.

IV. Colorimetry

Among a number of articles dealing with the general problem of the colorimetric specification of stimuli, the most comprehensive is the Report of the Colorimetry Committee of the Optical Society for 1920–1921 (**38**). This report includes: (1) suggestions for a standard nomenclature for physical, psychological, and psychophysical terms; (2) specifications of standard physical stimuli and standard conditions of experimentation; (3) a compilation of the best available psychophysical data relating color to its stimulus conditions; (4) a comparison of the principal methods of colorimetry.

A number of papers (**13**, **14**, **22**, **33**) discuss algebraic and graphical methods for the interconversion of colorimetric data obtained by monochromatic analysis and by various systems of trichromatic analysis. Judd (**24**) gives a method for calculating certain constants required in making these transformations.

Ives (**23**) applies algebraic processes of transformation to a series of actual measurements made by the two colorimetric methods, and finds serious discrepancies between the experimental and the calculated data. The experimental determinations were made by the author whose color vision is normal. The data used in the computations were (a) Koenig and Dieterici's results on the evaluation of spectrum light in terms of three "fundamental sensations," and (b) visibility determinations by Ives and others. The differences in the experimental and calculated data are attributed to disagreements in the visibility and color sensation data used in making the calculation, and to disagreements between these data and the characteristics of the eye used in making the experimental measurements.

A more extensive comparison of the experimental and computed values of dominant wave-length and purity has been carried out by Priest, Gibson, and Munsell (**31**, **32**). A large number of determinations have been made by three practiced normal observers and a few additional determinations by several unpracticed normal observers and two anomalous trichromats. As yet, only brief abstracts of this

work have been published. Consequently, no statement as to the results and conclusions can be given. The writer understands that the work is being continued on an extensive scale by Priest, Judd, and Gibson, with a view to a redetermination of the data on " fundamental sensations."

Houston and Dow (20) suggest a simple method and apparatus by means of which the colors of the spectrum can be evaluated in terms of varying proportions of red, green, and blue primaries. A set of results for a normal eye are given. The authors recommend that such determinations be made for a large number of observers.

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SPECIAL REVIEWS

CARL STUMPF. *Die Sprachlaute. Experimentell-Phonetische Untersuchungen nebst einem Anhang über Instrumentalklänge.* Berlin: Springer, 1926, pp. xii+419.

The distinguished author of this volume has rendered a signal service to psychology and to the science of phonetics by bringing together the results of his own painstaking experiments upon vocal sounds and those of other investigators in the same field. The systematic thoroughness and the critical insight with which varying detailed results are illuminated, and brought to a single focus, are truly amazing. But the task of the reviewer in summarizing the chief features of this work is somewhat appalling. For those who interest themselves in this subject, only a careful study of the book itself will suffice.

Stumpf upholds the main thesis of Helmholtz, both as regards the structure of the vowels and the general theory of hearing. As his previously published papers have indicated, he defends the "absolute" as against the "relativity" theory of Hermann. By three methods of approach—first, the test of sung vowels by resonating forks, secondly, the analysis of vowel-sounds with the aid of interference tubes, and thirdly, the synthesis of vowel-sounds produced by lip-pipes the tones of which have been reduced to purity by interference—Stumpf is able to demonstrate the fixed formants of the vowels, and their essential structure as partial tones all lying within the normal range of hearing.

While the formants are not, as Hermann contended, unharmonic to the tone on which the vowel is sung, they are restricted in their range. Excepting *U*, which varies with the fundamental, every vowel has its proximate basis in another vowel, *O* in *U*; *A* in *O*; *Ä* in *AO*; *E* in *O*; *I* and *Ü* in *U*. With C (129 v. d.) as fundamental tone, *U* finds its maximum intensity in C^1, *O* in C^2, *A* in G^2, *E* in G^1, and *I* in C^1; but the formants for *E* and *I* lie higher, between A^3 and D^4.[1]

Stumpf's present systematic treatise answers a number of questions

[1] The chief results of Stumpf's investigation have already been summarized in this journal, Vol. 17, 1920, pp. 228 ff, and are also discussed in my book on *Hearing*, 1924, Chapter IV.

which his previous papers on the subject left open. He now concludes that clangs and noises are specifically different, with no true transition from the one to the other. Thus, the unvoiced or whispered vowels, and the consonants, are relegated to noise, though possessing characteristics of pitch and vocality. Since he finds the pitch of whispered vowels to lie an octave higher than the formants of the corresponding voiced vowels, he concludes that their specific vocality cannot be attributed to a mixture of weak tones with the noises. In answer to the question why, with the same resonating position of the mouth, a whispered vowel should have its formant at a higher level of pitch than the corresponding voiced vowel, Stumpf writes: "I can only suggest the hypothesis that from the outset of this mode of speech the whispering impulse required a centrally conditioned reconstruction of the vowel character of whispered noises within certain limits." In other words, having no fundamentals, the whispered vowels are restricted to the region of the partials that would belong to the voice-tone for which the mouth resonator is set; this forces the pitch an octave upwards as an *Überblasungsgeräusch*. The analysis of the whispered vowel shows another difference from the voiced vowel, in that the sounding region is more or less continuous, and spreads like "tonal dust," as Stumpf calls it.

Regarding the analytic and synthetic characteristics of vocal sounds Stumpf suggests a reconciliation of the opposing views on "Complexes" and "Gestalten." A complex is defined as a totality of absolute contents, while a *Gestalt* is a totality of relations. The totality of different sensations as given in a clang constitutes a complex, whereas melodies, accords, and rhythms are *Gestalten*. Both complexes and *Gestalten* are perceivable with and without a differentiation of parts. Every complex, the parts of which are joined, has a perceived *Gestalt;* that is to say, relations exist, between its parts, which make of it a whole. But since relations are not bound to definite contents, then *Gestalten*, like melodies and accords, are transposable. The attributes of a complex are those of its constituent parts, whereas the attributes of a *Gestalt* are those of its relations. No two phenomena or functions ever appear in normal consciousness without being connected, however loosely, by some relation to a whole; but this whole is not a mere sum of the parts thus connected.

With the aid of this distinction, which he advances as something new, Stumpf concludes that clang-color is not a *Gestalt* as von Ehrenfels and Cornelius have maintained, and that consonance and dissonance are not complex-qualities as Krüger states them to be.

Despite the aid of this ingenious differentiation Stumpf can only leave open the question why a tonal complex $C^2 + G^2 + C^3 + E^3$, having certain intensity relations, can be heard either as the vowel *A* or as a harmonic chord of unequally intensive tones. He is, however, firm in his statement that it would be wrong to suppose we are here dealing with atomistically discrete units which in experience gradually form themselves into wholes. Although the particular question remains unanswered, Stumpf lists a number of conditions favorable to uniformity of hearing. These are: (a) the fusion of consonant partials, especially the six lowest—but Stumpf no longer attributes musical consonance to fusion, which he now regards as an accompanying phenomenon; (b) the pure tuning of all the harmonics, thus reducing the possibility of beats; (c) the identity of position from which the partials are sounded and in which the heard object seems to lie (slight temporal differences occasioned by different positions, while imperceptible as such, have, nevertheless, a physiological effect; and the local sign of a sound must be an original datum); (d) exact simultaneity; (e) favorable intensities among the partials; (f) a special centrally aroused physiological adaptation for uniform as distinct from multiform hearing; and, finally, (g) such psychological factors as volition, habit, and mental adaptation.

The reciprocal influence of partial-tone intensities, and their relation to the total intensity of the clang are subjected to a special series of experiments, the results of which are compared with those of other investigations. The conclusion is that the intensity of a clang is never greater than the intensity of its strongest component, and there is no increase of intensity in diotic as compared with monotic reception. (This conclusion applies only to tones, and not to noises.) The intensity may, however, be increased by difference-tones which coincide with the strongest partial. The weaker components of a clang may suffer some deprivation of intensity especially when the difference of intensity is marked.

In the Eberhardt experiments, where the intensity of the partials of a clang was matched with corresponding tones in isolation—the intensity being measured in physical terms—it was found that, while individual variations were marked, the intensity of a partial within a clang was sometimes less than 2 per cent of its objective intensity. So drastic a reduction, which goes far beyond his own results, leads Stumpf to suggest an anatomical explanation. According to this hypothesis three levels of the nervous system are involved in apprehension. At the peripheral level conditions obtain which account for

Stumpf's results with a slight deprivation of the weaker components. At a second level clang- and vowel-color are determined, while at a third level only the analyzed partials appear to be subject to a loss of energy, which is attributable to central resistance, and is individually quite variable.

Perhaps Stumpf's most important theoretical contribution in this work is the distinction he makes between two vowel-processes, each central in origin, namely, a fundamental process which varies chiefly with respect to brightness from *U* to *I*, and an accessory process coming within the range of G^1— G^4 to constitute the vocality *A* which rises, as it were, from the base-line *U* — *I*. This latent quality of the partials between G^1—G^4 is scarcely noticeable with a single tone, but is produced by a kind of catalytic effect when the fundamental or some other deep-lying partial is also present. The quantity of this accessory process increases from G to the middle of the *A*-formant, G^2—A^2, and then decreases, thus constituting a kind of vocal triangle, the corners of which are represented by *U*, *A*, and *I*, with *O* and *E* occupying opposite positions on its sloping sides.

This accessory process cannot be regarded as a genetic development of an original *U*—*I* type of vocality, because it is improbable that the human voice ever was restricted to the production of *U*—*I* sounds, which, at best, have only a relatively weak intensity, whereas the *A* sounds are capable of production with the full force of the lungs. One must also admit that the vocality of simple tones, as demonstrated by Köhler, is directly dependent upon this accessory process. The vocal color of pure tones is not the original of vocality. Instead, the empirical vowels are fundamental, and the vocality of pure tones is a reminiscence of these.

Finally, as regards the theory of hearing, Stumpf analyzes the Helmholtz conception into five theses: (1) The Fourier theorem; (2) Ohm's physical definition of a simple tone as a sine-wave, and every other tone as a sum of superimposed sine-waves; (3) Helmholtz's analysis of timbre; (4) Helmholtz's physiological hypothesis of resonators in the cochlea; (5) Helmholtz's psychological hypothesis that the sensations of hearing are analogous to these acoustical processes. Each of these five theses is defended. The first is undeniable; the second is only a definition; but the form of the wave as such, with its shifting phases, has no effect upon hearing. So far as simplicity of wave-form is concerned, the decided dissonances 5:9 and 5:11 should be nearer the chief consonances than the more complicated form of 7:10 (C:G♭) which, however, si a half-consonance.

"I think," remarks Stumpf, "that no *Gestalt*-psychology can overcome this discrepancy so long as it holds only to the wave-form"—a proviso which the *Gestalters* may be loath to accept.

The third thesis cannot be relinquished, since it is not a mere hypothesis but an essential requisite. The fourth thesis, however, is still hypothetical; and resonance in the cochlea may be but an analogy for summative effects which actually take place in the cortex. As for the fifth thesis, the psychological phenomena of tones and vowels are not mere sums of contents, since specific processes are necessary in order to constitute a whole out of these parts.

In a supplementary chapter analyses and syntheses are given of the clangs of numerous musical instruments, the characteristic formants of which are noted, together with many other special qualities that mark the individuality of different instrumental sounds.

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GATES, ARTHUR I. *Elementary Psychology.* New York: Macmillan, 1925. Pp. 583.

According to the author, this book was written primarily to meet the demand for an elementary textbook in psychology. The book is similar in type to the author's Psychology for Students of Education. It differs, however, in content and organization. It is interesting to note that there are a total of seventy-three illustrations in the book exclusive of statistical tables. This is a forward step following the underlying psychological principles of the educative process. The chapter headings are as follows: The Methods and Subject Matter of Psychology; The Rôle of the Receiving Mechanisms in Behavior Explained as Reactions; The Connecting Mechanisms; The Reacting Mechanisms; Native Equipment: Structures, Capacities, and the Theory of Specific Instincts; Sensations and Feelings; The Emotions; The Dominant Human Urges; The Rôle of the Dominant Urges in Habit Formation; The General Laws of Learning; Characteristics of Human and Animal Learning in Complex Functions; Economical Methods of Learning; Perception; Reasoning, Imagination, and Other Types of Thinking; Mental Organization and the Transfer of Training; The Influence of Internal and External Conditions upon Efficiency; The Nature of Individual Differences; Intelligence; The Measurement, Organization, and Significance of Various Human Traits.

Although the author states in the Preface that "The present work contains a much more extensive account of the introspective studies of conscious states and processes, . . ." than his previous work, yet the book is written from the general point of view of behavior. He writes: "Conceived broadly, psychology seeks to discover the general laws which explain the behavior of living organisms." The entire work is permeated with the point of view of educational psychology, each chapter contributing to the understanding of the general laws underlying the process of education. "Pure" psychology finds little room in it. The fact that the book is written from a dynamic and a behavior (not necessarily a Behavioristic) point of view, and the fact that the style of the author is exceptionally readable, probably account for the interest with which both elementary and advanced students are reading and studying it.

The material included in the book has been well chosen. From a practical and elementary point of view it fits admirably. At the end of each chapter are listed questions and exercises and general references. The two outstanding contributions of the author are readability and inclusion of more recent experimental material.

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DUNLAP, KNIGHT. *Old and New Viewpoints in Psychology.* St. Louis: Mosby, 1925. Pp. 166.

This book is a collection of three public lectures and two scientific papers. The chapters are quite complete in themselves, so will be given separate treatment.

The paper entitled "Mental Measurements" was prepared with the coöperation of Dr. Buford Johnson and Mr. Schachne Isaacs of Johns Hopkins, and was given as a lecture under the university auspices. It is in the main a statement that workers in the field of individual psychology should give more consideration to the principles of general psychology. The historical development of the mental test movement is given, and its rise is said to be due to the hopelessness of employing the simple measurements of experimental psychology. The author feels, however, that these same analytical measurements will probably be made use of eventually in conjunction with the more complex measurements in which the foundations have been laid, and that there is at present a considerable amount of experimental effort along this line which ought to be still further

encouraged. The author bemoans the slipshod methods sometimes employed in testing and blames behaviorism for some of this. Test results are not properly interpreted and the coefficient of correlation is much abused, he says. Important future developments are predicted along lines of industrial and character tests.

"Present Day Schools in Psychology" was also presented as a lecture under university auspices. Dunlap is the sole author of this and the subsequent papers. Psychology is viewed as having passed successively and rapidly four crises—introspectionalism, behaviorism, Freudianism, and instinctivism. The first three of these passing fancies are regarded by Dunlap as products of "idea" psychology, although they have been passed on to psychology by philosophy, physiology, and medicine, respectively. To the reviewer they seem like lively corpses and behaviorism seems to be actually thriving. However, the author limits several of his terms to meanings not now generally current—a fact which should be carefully kept in mind. For example, the introspectionist school is synonymous with the so-called structural or "reactionary" school of Titchener, and behaviorism with Watsonism. As the reviewer understands it, this excludes many if not most of the behaviorists from the scathing denunciations leveled at behaviorism.

Introspectionalism has become "the name of a vaguely conceived method of the observation of 'ideas.'" This view of psychology is rejected by Dunlap, who agrees with McDougall that one need accept neither introspectionalism nor behaviorism, but "psychology." This "psychology" is for Dunlap not the McDougall type, however, but the "common or garden" variety—apparently a species of functionalism, as this school is viewed with marked approval. It is neither vitalistic nor mechanistic, so its exact status will remain a puzzle to many. Watsonism (behaviorism in Dunlap's terminology) has passed through distinct stages. It at first threw overboard introspection in all its meanings, even eliminating all instructions from its experimental procedure. Later this "appalling or amusing" position was modified to include vocal and graphic behavior in place of the Titchenerian introspection, with the final result that now the differences in theory between the two extremists are only verbal.

Both the psychoanalytic and the instinct (McDougall's) psychology are said to be manifestations of the same tendency which is exhibited in the old faculty psychology. The common characteristics of a group of phenomena are noted and abstracted. The next step is to explain the phenomena by saying that they are manifestations

of that abstraction. (A very similar statement is to be found in a new book by the "behaviorist" A. P. Weiss, *"Theoretical Basis of Human Behavior!"*) The weak points and absurdities of psychoanalysis are well treated. At least it seems so to the reviewer. The instinct psychology is the soul psychology again. Dunlap, while strongly denying paternity in respect to behaviorism (which Watson claims), admits that he is the slayer of the instinct concept, and relegates it to the field of religion.

The chapters on "Psychological Factors in Spiritualism" and "Reading of Character" are from papers read to the Southern Society for Philosophy and Psychology. The reviewer feels that articles of this sort should be included more generally in elementary textbooks, as they aid the students in their problems far more than many items which are now generally discussed at great length.

Spiritualism is considered under three headings—the eagerness of people to accept spiritualistic claims, the presence of great men of science in spiritualistic ranks, and the sincerity of the mediums. Character analysis is discussed both with regard to history and probable future developments. Dunlap believes that when a scientific system of character measurement is developed, it will be on the basis of physiological and not anatomical signs. An appeal is made for an educational campaign against the present day quack character analyzers.

The paper entitled "Psychology of the Comic" was read to the Johns Hopkins' Women's Club. All comic is divided into the concrete and the ideal. There are ten concrete varieties, but all are similar in that the individual seeks to manifest his own superiority. These varieties range from the most primitive type, which includes bodily suffering and pain, through nine other classifications reaching the state where an individual apparently enjoys a joke on himself. Even here, he is really looking at himself in two aspects, one of which is superior. In the ideal comic no individual is presented as inferior or degraded, but confusing or puzzling material is given which can only be understood by the aid of a superior intelligence. Not all suggestions of superiority are comic, and the differentiation between the two is difficult. Darwin's well known theories are quoted, but it is admitted that there is no real experimental answer. "Funny papers" and comic movies are praised, as they tend to elevate humanity from the more primitive and cruel type of comic and make easier the substitution of still higher forms.

This book seemed very interesting to the reviewer, and well worth

reading. He feels that many psychologists will disagree with certain sections, especially chapter 2 and perhaps part of chapter 1, but such dissention may lead to clearer psychological thinking.

PAUL R. FARNSWORTH

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KANTOR, J. R. *Principles of Psychology.* New York: Knopf, 1924. Pp. xix + 464.

"The domain of psychology comprises the phenomena which we may call conscious or psychological reactions . . . the responses which psychological organisms . . . perform when they adjust themselves to the various stimulating objects" (p. 1). The word "conscious" does not reappear often in the sequel, nor is the adjective "psychological" given any clear-cut definition. "Psychological activities" are characterized by variability, differentiation, modifiability, integration, delay, and inhibition. The data of psychology consist of segments of behavior, bipolar acts, comprising the response and the stimulus.

Dr. Kantor is known as an outspoken opponent of piecemeal psychologizing. Once having listed the different *possible* kinds of behavior segments, he proceeds to the task of describing psychological phenomena by considering at the first of his book rather than at the end the concept of Personality (Chapters III and IV), described as a sum of reaction systems functioning in contact with their appropriate stimuli (pp. 75, 92). The behavior equipments are divided into abilities, skills, habits, tastes, etc., but "reaction systems and behavior segments are abstractions derived from the behavior of persons" (pp. 89–90).

A genetic method then is followed. The simplest or foundation segments of behavior are canvassed: reflexes, tropisms, random movements, instincts, and general capacities are characterized (Chapter V). The author is at pains to avoid both the springs of action conception of instinct and the physiological conception of innate forces: for him it is impossible to assume any kind of action mechanisms "not developed or derived from stimuli situations."

On this foundation are developed (Chapter VI) the basic reactions that early become so definite a part of the individual's behavior equipment that they constitute his particular identity, and so determine what later reactions he acquires: adaptive, expressive, manipulative, acquisitive, etc.—an expression here of the present day

tendency to reinterpret what used to be called instincts as compounds largely of habits.

In keeping with another contemporary tendency the further genetic developing of the individual's adjustments is presented as Societal Conduct; and twenty-five pages of analyses are offered of "suprabasic," "contingential," "idiosyncratic," and "cultural" behaviors (Chapter VII).

Turning now from the genetic mode of treatment, Kantor gives us cross-section analyses of important types of reactions. The presentations of Attention (Chapter VIII) and Association (Chapter XI) are typical. "On the intimate functional side attention activity consists essentially of a process by which the objects and conditions in the person's surroundings assume their particular stimulational functions. Through the attention action the objects surrounding the individual become actualized into stimuli which call forth responses to them. In general, every specific attentional process, namely, the actualization of a stimulus object into a stimulus, is a result of a definite historical development in the lifetime of the reacting individual. In the first place, attentional reactions presuppose the prior transforming of objects into stimuli objects, in other words, a prior attentional process. . . . Once the surrounding objects have taken on stimulational functions they may be said to have entered into a psychological relation with the given individual in addition to the non-psychological relation of merely constituting his surroundings; so that in the future these objects can at a particular moment change in their relations to him from the non-psychological relation of being present to the psychological relation of being responded to. Before the individual can perform any sort of psychological response to his surrounding objects, persons, and conditions, he must get into such a psychological relation with them." (Pp. 216, 217.) Twenty pages are used for a detailed classification of associations. "We positively cannot accept any sort of neural basis for association." "The nervous system is clearly neither a mechanism nor a basis for association or any other kind of psychological process." (Pp. 340, 342.)

A more effective analysis is made of some thought processes. The acts involved in thinking and remembering are implicit actions, responses to absent stimuli (Chapter X). Their study "presents us with no different problem than the observation and description of overt acts" (p. 312). Originally "a differential reaction system . . . was acquired in the original contact with the object." Then when the object is absent "the differential reaction system can still be put

into operation by a substitution object." "The person essentially repeats in some form a previously developed mode of activity . . . implicit reactions are re-occurring reaction systems aroused by some substitution of the original stimulus." Such implicit reactions are "morphologically and functionally continuous with our overt responses"; but as they tend to become symbolic they may come to bear little or no resemblance to the response (pp. 299, 298). "Image responses . . . may be looked upon as vividly and partially repeated reaction systems . . . to some specific situation, plus the speech reactions descriptive of the objects and events reacted to." Moreover, "much of our image experience is really a verbal self-analysis of how we respond to an absent object," and may include "subtle actions of the person which constitute exact counterparts of various phases of the original responses." (Pp. 307, 308.) Perception, Feeling and Emotion, Knowing Reactions, Volitional Reactions, and Habit Reactions are analyzed. (Chapters IX, XII–XV.)

This is no book for the immature student; it is addressed to the profession. What then does it contribute to psychological knowledge or methods of to-day?

"Psychology is more closely related to ecology or bionomics than to any other biological science" (p. 20). Kantor sees the subject not as a study of man (and infrahuman animals) but as a study of man-and-environment relationships. Man isolated even for a moment from his surroundings is not the object of this special science, it must be man *in situ*. Psychology as written in this book turns out to be a series of analyses of environment-organism relations, but not a study of ways-in-which-organism-adjusts-to-environment with primary emphasis upon the organism in any concrete way, nor as a study of types-of-environment-that-affect-organisms. For analogy one might consider such a concept in physical science as the principle and the laws of gravitation, a relationship that is a legitimate object of any study without primary attention to the things related. But this relationship is fairly simple and definite; the same can hardly be said of organism-environment relationships in their manifold complexities. The elaborate classifying and reclassifying of such relationships is in grave danger of turning itself into a dialectic. Or if for analogy one turns to relational concepts in the field of biology (commensalism, symbiosis, parasitism, mimicry, etc.), he finds relationships that are indeed statable as relationships but still are not usable until described as relationships found between this specific kind of organism and that specific kind, appearing at such and such

ages, under such and such identifiable food conditions, etc. Kantor is willing to "accept the fundamental methodological principle of describing only the intimate details of responses with the corresponding minutiae of stimulation," and in this book to give "generalized descriptions that are suggestive of the essential specific details of the responses studied." (Pp. xvi, xvii.) Frankly it must be said that vast tracts of this book given over to this analysis *in abstracto* will seem to most psychologists rather barren of nourishment. Dr. Kantor's preoccupation with the description of relationships is manifestly a revolt against the all too common tendency to hypostatize aspects of human and infrahuman psychological reactions that are merely aspects; but the reviewer raises the query whether this method of mere abstract description, of *mere* characterization of relationships, does not fall far short of the scientific ideal of analyzing and describing with a view to the identification of "causal" or inevitable sequences that haply may ultimately serve for purposes of prediction and control. Surely, psychology is becoming a science less in the mediaeval logical sense of concept-analyzing and more in the modern natural sense of sequence-determining; it is devoted to the identifying and measuring of *factors,* factors that influence and produce occurrences.

Strong dissent is indicated by the author from the concepts involved in several other brands of psychology: from the dealing with "mental states" "which do not have properties shared by other natural phenomena"; from the ascription to man of "inner driving forces"; and from the confusion of the reactions with the biological organisms that perform them. He is frankly opposed to all "mentalisms," "animatisms," and "behaviorisms." The whole book evidences an ignoring of the distinction between the subjective or introspective and the objective or behavioristic modes of approach to psychological facts. This may be due to a common confusion of this distinction of methods with certain traditional epistemological and metaphysical distinctions. That the latter need be given no attention by the working psychologist the reviewer is inclined to hold (and partly because he is skeptical of the validity of these distinctions *per se!*). But it is another thing to assume that the difference between the two methods of observation, two modes of technique, may be overlooked, without introducing some confusion and even vagueness into the descriptions of the occurrences reported. Furthermore, the book contains no hint that psychology is an experimental field.

It remains for us to speak of the author's style—and in this case the matter is of vital importance. The literary mannerisms appearing in the book tend to set up a barrier between the author's thought and his readers; and this can have only the effect of decreasing his audience by half. These mannerisms include a frequent inversion of word order, a practice of adjective coining ("inapparent," "performative," "perspectival," "subpersonalistic," "animatistic," "subreactionalistic"), and a repetitious mode of describing.

J. F. DASHIELL

THE UNIVERSITY OF NORTH CAROLINA

BOUSFIELD, PAUL. *Pleasure and Pain, A Theory of the Energic Foundation of Feeling.* New York: Dutton, 1926. Pp. vii+114.

Little more in the way of a warning need be said than that the author spends the first fifteen of his 114 pages in detailing the reasons why he no longer accepts as axiomatic the two instincts of reproduction and self-preservation. The remaining 100 pages seem to be on much the same level of psychological naïveté. Intellectualism and the "psychologist's fallacy"—which here surely should receive some other name—color almost every notion. The author's thesis is the familiar one that "pain" is the result of tension, that pleasure comes from the relief of tension. Imagination and psychic tensions and reliefs complicate the picture. The tension and its relief may become unconscious and only the pain or pleasure or their anticipation remain. The chief claim to novelty is the use of these principles to explain masochism.

HORACE B. ENGLISH

WESLEYAN UNIVERSITY

WEMBRIDGE, ELEANOR ROWLAND. *Other People's Daughters.* Boston: Houghton Mifflin, 1926. Pp. ix+333.

Outside the realm of science, but profoundly influenced by it, lies the field of the interpretation of life by a kind of direct sympathetic intuition. Even the toughest-minded psychologist would probably admit that much of the value of his science and of its interest for him lies in its ultimate contribution to this field; certainly there is little justification otherwise for our driving students who are not to be psychologists through our elementary courses. Nor is such an attitude dangerous to scientific rigor; it is only when the interpre-

tative motive is allowed to react back upon psychology that harm results.

In the book before us, this last has not been done. The author, an accomplished psychologist, has been for several years practicing the art of understanding erring and wayward women. No one can doubt, I think, that her psychological upbringing has been invaluable to her in this work. But from her practice has emerged apparently no effort to modify scientific knowledge. She does not attempt to give us what certain Germans are calling a "culture" psychology. Instead she has summarized her wisdom in an art form, and because she has genuine powers as a writer, she succeeds unusually well in getting her readers to feel as she, a trained psychologist, feels, in the presence of certain human problems.

As collateral reading the book may do much to vivify a course in social psychology. It may assist to induce a more helpful attitude towards others facing life's baffling problems. But to the present reader the chief gain was a frank enjoyment of the reading, without which it could not be what it set out to be.

HORACE B. ENGLISH

WESLEYAN UNIVERSITY

Problems of Personality: Studies Presented to Dr. Morton Prince, Pioneer in American Psychopathology. N. Y.: Harcourt, Brace. London: Kegan Paul. 1925. Pp. 434.

Dr. Morton Prince has long been a distinctive and in the best sense popular figure among psychologists, while the contributions he has made personally, and through his editorial interests has helped others to make, are not easily measured. It is always pleasant to give recognition to such facts, and the *Festschrift* is one of the forms such recognition can take. The contributors in the order of their papers are: Elliot Smith, Ernest Jones, William A. White, Ed. Claparede, G. M. Stratton, C. Macfie Campbell,* A. A. Roback,* Pierre Janet, C. K. Mills, E. W. Taylor,* T. W. Mitchell, Charles L. Dana, J. Ramsay Hunt, Bernard Hart, Knight Dunlap, C. S. Myers, Wm. McDougall,* C. G. Jung, William Brown, H. H. Goddard, S. E. Jelliffe, J. T. MacCurdy, H. S. Langfeld, L. H. Horton. It is obvious that so far as these men have put themselves into their writings, the work that gives in one volume any little cross section of so many prominent colleagues is a worth-while one to own.

* Members of the Board of Editors, Dr. Roback being Secretary.

An interesting study could be made of the subject of title for psychological works. In several recent cases the reviewer has had occasion to comment on their nondescriptive character; and usually it has been such as to lead one definitely to expect something which is not there. Even "Problems of Personality" strains its inclusive capacity in comprehending such offerings as those of Stratton, Mills, Dana, Ramsay Hunt, and Langfeld, not to mention that intellectual Damon-and-Pythias, Ernest Jones and Knight Dunlap. The introduction speaks of disfavor to the *Festschrift* in this country, and while it can only be called "slight" yet it is likely that the American temperament lends itself less well to this type of expression. The present volume, to be sure, is international in character, embodying a large proportion of well known names in the field of abnormal psychology; Adolf Meyer and Bleuler are the names that may be most missed. A bibliography of Dr. Prince's writings is included.

The initial contribution, by Elliot Smith, is distinctive for a scientific rigor of thinking to which a large part of personality study has, for better or worse, had difficulty in adapting itself. One wonders if Ernest Jones has repressed the fact, or deems it beneath his notice, that "clinical" psychology is in wide and apparently established use in this country for something of very different antecedents from what he has in mind. Stratton presents some striking instances of efficient response under specially dangerous situations, which one might look upon as preservation of integrations under emotional stresses that usually disrupt them. But the question arises of how much emotion there really was (it is not introspectively described) and whether the dissociation might not have been in some way a surrogate of emotional response. This would be suggested in the comments concerning Livingstone. Campbell, one of the editors (whose middle name the volume consistently misspells), criticises recent contributions to personality study in the narrower sense, especially those of Kretschmer and Bleuler.

Roback has perhaps the most painstaking contribution to the volume; an excellent review of the more philosophical trends and principles in personality study, with considerable material of his own. Janet develops phases of his "Fear of Action" paper in a brief note on "super-real" memories, chiefly the report of a case. One particularly regrets the shortness of this paper. The two articles of widest interest will probably be Taylor's investigations of the Salem witchcraft trials, which is one of the more detailed contributions, and

Dana's brief study of neurological points involved in the signatures of William Shakespeare.

C. S. Myers offers studies of two children, from which type of observations he concludes that psychological factors may play a greater rôle in symptoms of, or simulating, mental deficiency than is generally realized. McDougall turns his polemical talents upon the social psychology of Freud. It is an artillery attack, for which Elliot Smith may have been said to have provided the aerial reconnaissance. The fire is generally well directed but one may question if social psychology has been sufficiently within the range of Freudian principles to justify the expenditure of ammunition. Jung's paper strikes one as a *réchauffée* (it is not the only one that would bear this designation) of the introvert-extravert concept, and its more direct derivatives. Jelliffe writes concretely on the relation between psychogenic conflict and physical disease.

It is always a delicate task to criticise a volume with the emotional tincture of a *Festschrift,* but the present instance has drawbacks inherent in the character of the task undertaken. The natural contributors to a *Festschrift* are persons of established status who are bound to its object by ties of close friendship if not affection; and competent juniors whose formal association with the object suffices, and to whom the distinction of contributing to the document is a sufficient spur to their best efforts. Such conditions are not present in Prince's case. He has no distinctive group of pupils or leadership of a cult. Thus there was no well-defined body of persons who might be looked to in the matter. Any person prominent in a wide field would be as much in place as the average contributor. A distinguished group evidently did feel appropriate interest, but the result of including this number of contributors placed a limit on the length of offerings that seriously modifies their individual significance. There is not space for many to develop their themes in more than a very sketchy way.[1] Some of the contributions have the air of after-dinner addresses rather than of objective building material for the fabric of psychological knowledge and insight. One of the papers was presented in 1916, and another is referred to a still earlier origin. It is thus seriously questionable if it was wise editorial policy to go

[1] Also, through some mischance, the correlation between the page numbers in the index and those in the body of the volume, while thought to be positive, is not sufficient to render the former generally serviceable, at least from the point of view of "manifest content."

so far into the highways and byways for contributors.[2] Their general status is beyond criticism, but if the persons comprising the board of editors had wished to render Dr. Prince a signal honor in the form of a *Festschrift* they would have done a better service to psychology, at least, by writing it themselves.

There is a man of status comparable to Dr. Prince's, though not one of the present contributors, in whose honor his juniors once desired to give a little spread. Owing to a self-effacing disposition it was problematical if he could be induced to appear at the function. He had, however, a weakness for the anti-alcohol movement, and one of his pupils inveigled him to the hall on the pretense of securing his presidency at the founding of a new temperance society. Regrettable as it would be to secure, or attempt to secure, the presence of Dr. Prince through such deceptive measures, it is certain that the honors, possible and merited, are by no means exhausted in this present token, and it may yet be demonstrated that in such settings the libido expends itself not less readily on nutritional than on intellectual levels.

F. L. WELLS

BOSTON PSYCHOPATHIC HOSPITAL

BISCH, LOUIS E. *Clinical Psychology.* Baltimore: Williams and Wilkins, 1925.

The author of *Clinical Psychology* confesses modestly to the desire to write a book that will give the teacher a working basis by means of which she may be able to recognize an atypical child in the classroom and to know how best to handle the situation. He succeeds only in throwing together in a most unsatisfactory manner much material that lies within the realm of clinical psychology. Where he covers the material adequately, he involves himself in technical details which can be of no service to the teacher. In sections in which there is a curtailment of material for the sake of brevity and better understanding, he limits himself to generalizations which are incomplete and often misleading. Such a statement as "if a mother gives birth to a congenital ament the possibility is that the next child will be similarly afflicted," is an outstanding example of a misleading generalization which can be extremely harmful. "Moral perversity in childhood may be due to bodily diseases (such as eye strain,

[2] A colleague of mine, whose psychology was better than his German, kept alluding to a similar undertaking in which he was interested, as a "*Schriftfest.*"

infected teeth, tonsils, etc.) or to physiological causes (menstruation in girls, emotional upheavals incident to adolescence, etc.)," and " a child whose excellence in school work slows up on classroom exercises should always be suspected of being neurotic," are other examples of incomplete generalizations which may very well throw the teacher on the wrong track, instead of pointing the way toward a better diagnosis and treatment of the atypical child.

The author introduces his book by stating that " the book has been long in contemplation and even longer time has been required for its writing." If he had been able to add that much reading had preceded the writing he might have been able to produce a much more satisfactory work on clinical psychology. Unfamiliarity with current literature is suggested in the very first chapter, devoted to a historical treatment of Clinical Psychology.

What is good in the chapter is borrowed from Barr, but the historical treatment is most significant for what has been omitted. The chapter ends with the arrival of Seguin in the United States. Seguin's work represents only the beginning of the scientific diagnosis and treatment of feeblemindedness with which the term clinical psychology has been associated. The term was first used by Lightner Witmer, and the founding of the Psychological Clinic of the University of Pennsylvania in 1896 represents the first organized use of the clinical method in the field of psychology in the diagnosis and treatment of atypical children. The opening of psychological clinics in this and other countries and the extension of the field of clinical psychology within the last thirty years make one of the most significant and interesting chapters in the history of clinical psychology—a chapter which the author has failed to write. Neglect is the most charitable word to use in connection with the author's failure to write this chapter, or to mention Witmer's name in an historical treatment of clinical psychology.

It can only be the author's unfamiliarity with the literature that makes it possible for him to omit the names of Spearman and Pearson in referring to mathematical technique in the treatment of test results. An author who writes " that premature physical traits of adolescence do not necessarily mean a correlated premature development of intelligence; in fact the contrary is the rule," cannot be acquainted with the works of Baldwin, Crampton, and Lutz. An author who distinguishes between general intelligence tests as those in which " the results are scored in terms of years as correlations with the mental development of a child in school under ordinary

educational conditions" and performance tests as those "in which the scoring is made according to group abilities rather than according to years," and then adds "that both types of tests accentuate intellectual capacity," cannot have read deeply or extensively on the subject of tests in relation to clinical psychology. Similar statements can be duplicated *ad nauseam*.

It is interesting to find that only two or three books published later than 1915 (the latest being 1922, another book by the author frequently referred to in the text) are quoted in the present writing. The latest reference in the section on mental tests is a book dated 1920, in spite of the fact that many significant contributions in the way of books and periodical articles have been made since that time. A few books of later vintage, one as late as 1924, are included in the bibliography found in the appendix, B, but even this bibliography hardly seems to have been prepared with "painstaking care."

The author shows himself to best advantage in the chapters which deal with medical material and in a chapter devoted to the technique of interviewing. About 100 pages are devoted to summaries of cases examined in the Clearing House for Mental Defectives. The summaries are on the whole quite adequate, but they indicate a failure on the part of the clinicians to make use of objective tests which are the distinctive tools of the psychological clinic.

On the whole this work on Clinical Psychology seems to be a product of a good doctor turned bad psychologist. In this connection might be discussed the author's insistence on the neurologist as a final authority in the psychological clinic, but this would unnecessarily complicate and make even more unpleasant a review that is already too much filled with unpleasant reflections.

MORRIS S. VITELES

UNIVERSITY OF PENNSYLVANIA

CARREON, M. L. *Philippine Studies in Mental Measurement.* Yonkers: World Book, 1926. Pp. xiv+175.

The purpose of this book is not quite clear. Is it supposed to give the American reader some notion of education in the Philippines and the uses of tests there, or is it supposed to be a book introducing American tests to Philippine teachers? If the former, then the brief account of educational conditions in the Philippines is totally inadequate, and the general chapters on tests in this country quite superfluous; if the latter, then the descriptions of tests and methods of

testing are much too brief and the general chapter on Philippine education superfluous. About half of the book is of this general type, giving elementary descriptions of the testing movement in this country and of general educational conditions in the Philippines. Much of the description of tests and their uses is summarized from American articles and books.

The author gives a useful summary of previous testing in the Philippines. If this is a complete account, it shows very little work done up to the present time. The original contribution on the part of the author is the description of the results of the Haggerty Reading and the Haggerty Intelligence Tests to 345 city and 320 country children in elementary and high schools. These results are shown for city and country separately and comparisons are made with the author's norms. In addition a more detailed analysis is made of each of the subtests.

The comparisons show in general the country children below the city and both of these much below the American norms. Only in one grade in one test does the percentage reaching or exceeding the American norm exceed 50. Generally these percentages hover around 10 or 20. In many instances no children reach the American norm. Grade by grade, therefore, Filipino children are far below American standards both as regards reading and intelligence, as tested by the Haggerty tests. The author does not give age comparisons for his intelligence data. If, as we believe, Filipino children are chronologically three or four years older than American children in the several grades, then age comparisons on the intelligence tests must show a tremendous difference. Is this due to the fact that intelligence tests using the English language or at least calling for the understanding of the English language in their directions were used, or is it due to real differences in intelligence? Nowhere does the author face these interesting and difficult questions. He seems to assume that these tests are more or less adequate to measure the intelligence of the Filipino child, or at least could be made so with a few minor alterations. If that is so, how are we to explain the enormous differences in the intelligence scores of Filipino and American children?

As a pioneer piece of work in the field of measurement in the Philippines the book is extremely interesting, and it is to be hoped that it will stimulate other educators in the Philippines to continue in the same direction.

R. PINTNER

TEACHERS COLLEGE, COLUMBIA UNIVERSITY

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NOTES AND NEWS

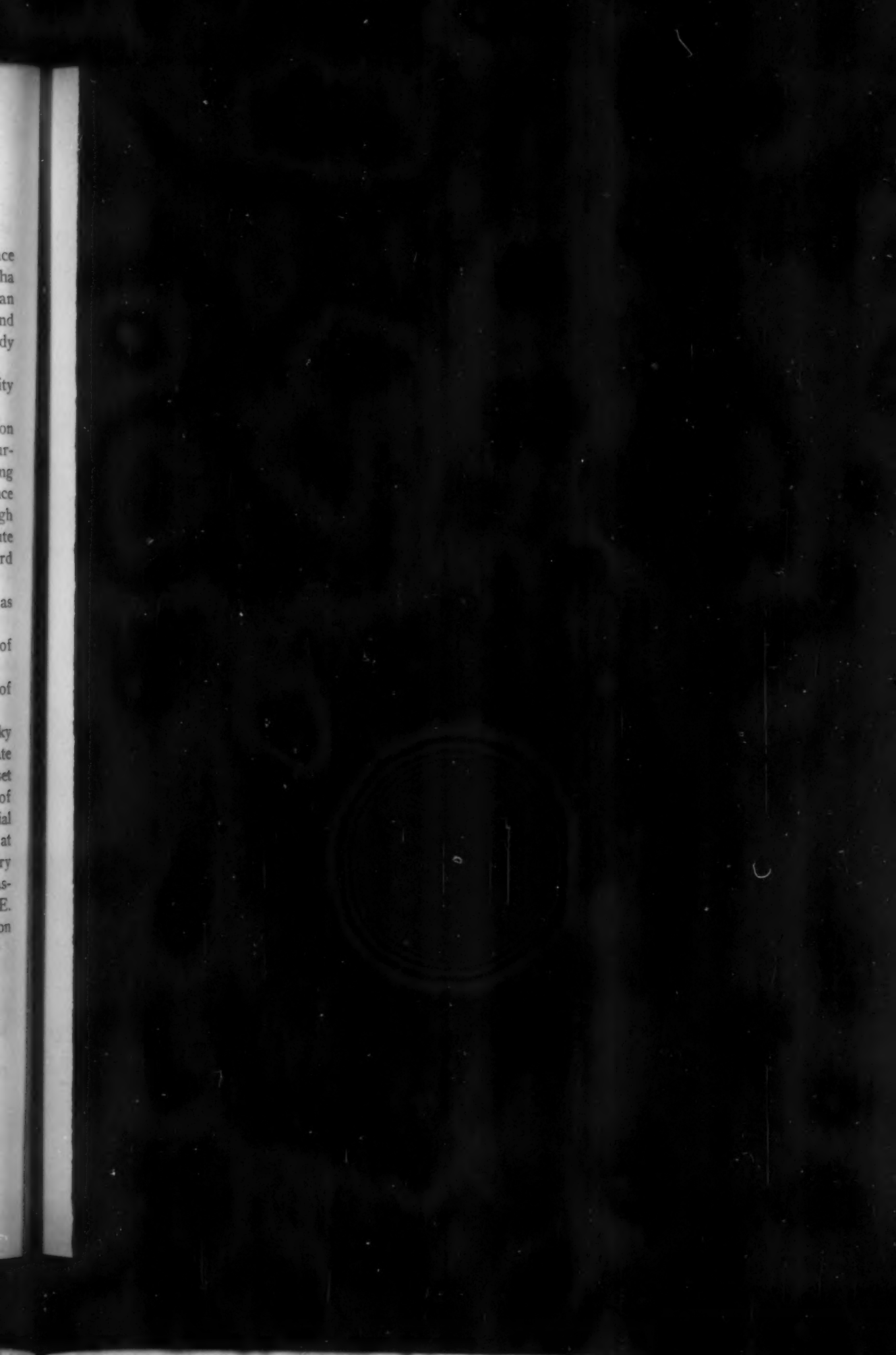
AMONG the research fellowships granted by the Social Science Research Council are the following for 1926–1927: Dr. Martha Guernsey, of the University of Michigan, who will study human behavior, especially in children in the light of gestalt principles, and Heinrich Klüver, of the University of Minnesota, who will study eidetic disposition in different racial and national groups.

DR. ELIOTT P. FROST, professor of psychology at the University of Rochester, died on September 3, aged forty-two years.

THE Commonwealth Fund has announced the establishment on July 1, 1927, of an Institute for Child Guidance. One of the purposes of the institute will be "to provide facilities for the training of psychiatrists and graduate psychologists in practical child guidance work. Annual fellowships for this purpose will be offered through the National Committee for Mental Hygiene with which the institute will be affiliated." The work of this fund is directed largely toward the prevention of juvenile delinquency.

DR. CHARLES A. DICKINSON has accepted an appointment as professor of psychology at the University of Maine.

DR. HULSEY CASON has been appointed assistant professor of psychology at the University of Rochester.

DR. KIMBALL YOUNG has been appointed associate professor of sociology at the University of Wisconsin.

THE department of psychology at the University of Kentucky has this year added to its staff Dr. Gardner C. Basset, as associate professor, and James L. Graham, as assistant professor. Dr. Basset was formerly at the University of Pittsburg and will have charge of clinical work and will give advanced courses in abnormal and social psychology. Professor Graham, whose graduate work has been at Columbia and Peabody, will devote himself to experimental laboratory courses. Prof. Paul L. Boynton will continue his interest in measurement, child development, and learning courses. Dr. Vivian E. Fisher, who was with the department last year, has taken a position at New York University.